

CLAIM

1. A communication system in which a plurality of base nodes communicate through a plurality of communication media each formed of at least one relay node, wherein

5                   said base node includes an assuming unit which handles a plurality of ports connected to said plurality of communication media among ports belonging to said base node as one virtual port to assume said plurality of communication media to be one node.

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2. The communication system according to claim 1, wherein three or more said base nodes are connected with each other through the plurality of communication media each formed of at least one relay  
5                   node.

3. The communication system according to claim 1 or claim 2, wherein said assuming unit includes a forwarding data base which registers, for one destination, a plurality of pieces of forwarding  
5                   information for transferring a data frame transmitted from a certain transmission source to a predetermined destination.

4. The communication system according to

claim 1 or claim 2, wherein said assuming unit includes a port mapping table which correlates at least one port of said base node with one virtual port, and a forwarding data base which registers at least one said virtual port in forwarding information for transferring a data frame transmitted from a certain transmission source to a predetermined destination.

5. The communication system according to any one of claim 1 to claim 4, wherein the relay node forming said plurality of communication media is a node which transfers a second layer data frame of an OSI (Open Systems Interconnection) network model.

6. The communication system according to claim 5, wherein said data frame is any of an Ethernet (R) frame having a frame format of Ethernet(R), a data frame having a frame format of ATM (ATM cell), a data frame having a frame format of a frame relay (frame relay frame) and a data frame having a frame format of FDDI.

7. The communication system according to any one of claim 1 to claim 4, wherein a frame format of a data frame transferred to at least one said communication medium is different from a frame format of a data frame transferred to other said communication

medium.

8. The communication system according to claim 7, wherein a frame format of a data frame transferred by an arbitrary communication medium among said plurality of communication media is an arbitrary combination of frame formats of Ethernet(R), IP (Internet Protocol), ATM, a frame relay and FDDI.

9. The communication system according to claim 7 or claim 8, wherein when transmitting a data frame to said communication medium having a different frame format, said base node transmits said data frame with header information of the frame format of said communication medium added and when receiving a data frame from said communication medium, receives said data frame with the header information of the frame format of said communication medium removed.

10. The communication system according to any one of claim 1 to claim 9, wherein a link connecting said base node and said plurality of communication media is any of or an arbitrary combination of Ethernet(R), ATM, a frame relay, ADSL, an analog dial-up line, ISDN, FTTH and CATV.

11. The communication system according to any

one of claim 1 to claim 10, wherein a link connecting said base node and said plurality of communication media has an arbitrary link speed.

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12. The communication system according to any one of claim 1 to claim 11, wherein the plurality of said base nodes transmit and receive a keep alive frame to/from each other to obtain a communication state of the communication system.

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13. The communication system according to claim 12, wherein said keep alive frame is broadcast by said relay node forming said plurality of communication media.

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14. The communication system according to claim 13, wherein said keep alive frame has a destination address which enables recognition as an unknown unicast frame in said relay node forming said plurality of communication media.

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15. The communication system according to any one of claim 12 to claim 14, wherein said base node obtains a communication state of the communication system from information recited in said keep alive frame or an arrival state of said keep alive frame, or from both.

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16. The communication system according to any one of claim 12 to claim 15, wherein a communication state of said communication system is any of or an arbitrary combination of a failure, a communication band and a delay.

17. The communication system according to any one of claim 1 to claim 16, wherein said base node determines a port from which a data frame is to be output based on a predetermined algorithm.

18. The communication system according to claim 17, wherein said algorithm is any of a system of determining a port from which a data frame is to be output by a round robin or a weighting round robin, a system of determining a port from which a data frame is to be output based on header information of the data frame, and a system of determining a port from which a data frame is to be output based on the contents recited in a pay load of the data frame.

19. The communication system according to claim 18, wherein when said algorithm is a weighting round robin, a probability that a port belonging to said base node and connected to said communication medium will be selected as a port from which a data frame is to

be output is determined by a link speed of a link connecting said communication medium and said port.

20. The communication system according to claim 18, wherein when said algorithm is a weighting round robin, a probability that a port belonging to said base node and connected to said communication medium  
5 will be selected as a port from which a data frame is to be output is determined by a communication state of said communication system.

21. The communication system according to claim 17, wherein said algorithm is a system of determining a port from which a data frame is to be output based on header information of the data frame and  
5 the contents recited in a pay load of the data frame.

22. The communication system according to any one of claim 12 to claim 16, wherein said base node determines a port from which a data frame is to be output based on a communication state of said  
5 communication system.

23. The communication system according to any one of claim 12 to claim 16, wherein said base node changes said forwarding data base based on a communication state of said communication system.

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24. The communication system according to any one of claim 12 to claim 16, wherein said base node

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includes an address management data base which manages a corresponding relationship between all the hosts connected directly or through at least one node to a port not connected to said communication medium among ports belonging to said base node of a communication partner and said base node of the communication partner, and

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changes a virtual port registered in output port information of said forwarding data base based on a communication state of said communication system.

25. The communication system according to any one of claim 12 to claim 16, wherein said base node changes said port mapping table based on a communication state of said communication system.

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26. The communication system according to any one of claim 12 to claim 16, wherein said base node determines a port from which a data frame is to be output based on a failure occurrence position, or on the number of failures occurring, or on both.

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27. The communication system according to claim 26, wherein said base node determines a port from

which a data frame is to be output based on a kind of  
data frame transfer methods including unicast transfer,  
5 broadcast transfer and multicast transfer.

28. The communication system according to any  
one of claim 12 to claim 16, wherein said base node  
includes a filtering mechanism for preventing a  
plurality of times of reception of the same data frame  
5 from said plurality of communication media.

29. The communication system according to any  
one of claim 12 to claim 16, wherein when detecting  
recovery from a failure, said base node preferentially  
transfers a data frame having high priority or transfers  
5 a data frame having low priority with a communication  
band limited.

30. The communication system according to any  
one of claim 1 to claim 11, wherein said base node  
determines a port from which a data frame is to be  
output based on a communication state of a port  
5 belonging to said base node.

31. The communication system according to any  
one of claim 1 to claim 11, wherein said base node  
changes said forwarding data base based on a  
communication state of a port belonging to said base



5 node.

32. The communication system according to any one of claim 1 to claim 11, wherein said base node changes said port mapping table based on a communication state of a port belonging to said base node.

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33. The communication system according to any one of claim 1 to claim 11, wherein said base node includes an address management data base which manages a corresponding relationship between a host connected directly or through at least one node to a port not connected to said communication medium among ports belonging to said base node of a communication partner and the base node of said communication partner.

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34. The communication system according to any one of claim 1 to claim 11, wherein said base node includes an address management data base which manages a corresponding relationship between a router connected to a port not connected to said communication medium among ports belonging to said base node of a communication partner and the base node of said communication partner.

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35. The communication system according to claim 24, wherein said base node creates said address management data base by transmitting and receiving a

learning frame.

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36. The communication system according to any one of claim 1 to claim 11, wherein said base node transmits and receives a data frame whose pay load stores a node identifier of a router connected to said base node and notifies each other of the node identifier of the router connected to said base node to create said address management data base.

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37. The communication system according to claim 24, wherein said base node transmits and receives an Ethernet (R) frame with a VLAN tag added which stores a VLAN identifier assigned to a combination of said base node to which a transmission source belongs and said base node to which a destination belongs to create said address management data base.

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38. The communication system according to claim 37, wherein said VLAN identifier has a node identifier of said base node to which a transmission source belongs and a node identifier of said base node to which a destination belongs calculated by predetermined operation.

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39. The communication system according to claim 1 to claim 38, wherein the relay node forming said

communication medium broadcast-transfers data frames including a broadcast frame and a keep alive frame by  
5 using a broadcast frame with an expansion tag.

40. A node as a base communicating with each other through a plurality of communication media each formed of at least one relay node in a communication system, comprising an assuming unit which handles a  
5 plurality of ports connected to said plurality of communication media among ports belonging to said node as a base as one virtual port to assume said plurality of communication media to be one node.

41. The base node according to claim 40, wherein said assuming unit includes a forwarding data base which registers, for one destination, a plurality of pieces of forwarding information for transferring a  
5 data frame transmitted from a certain transmission source to a predetermined destination.

42. The base node according to claim 40, wherein said assuming unit includes a port mapping table which correlates at least one port of said base node with one virtual port, and a forwarding data base which  
5 registers at least one said virtual port in forwarding information for transferring a data frame transmitted from a certain transmission source to a predetermined

destination.

43. The base node according to any one of claim 40 to claim 42, wherein a frame format of a data frame transferred to at least one said communication medium is different from a frame format of a data frame transferred to other said communication medium.

44. The base node according to claim 43, which when transmitting a data frame to said communication medium having a different frame format, transmits said data frame with header information of the frame format of said communication medium added and when receiving a data frame from said communication medium, receives said data frame with the header information of the frame format of said communication medium removed.

45. The base node according to any one of claim 40 to claim 44, wherein a link connected to said plurality of communication media is any of or an arbitrary combination of Ethernet(R), ATM, a frame relay, ADSL, an analog dial-up line, ISDN, FTTH and CATV.

46. The base node according to any one of claim 40 to claim 45, which transmits and receives a keep alive frame to/from each other to obtain a communication state of the communication system.

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47. The base node according to claim 46, wherein said keep alive frame is broadcast by said relay node forming said plurality of communication media, with a destination address recognized as unknown by said relay node forming said plurality of communication media recited.

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48. The base node according to claim 46 or claim 47, which obtains a communication state of the communication system from information recited in said keep alive frame or an arrival state of said keep alive frame, or from both.

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49. The base node according to any one of claim 46 to claim 48, wherein a communication state of said communication system is any of or an arbitrary combination of a failure, variation of a communication band and a delay.

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50. The base node according to any one of claim 40 to claim 49, which determines a port from which a data frame is to be output based on any of algorithms of a system of determining a port from which a data frame is to be output by a round robin or a weighting round robin, a system of determining a port from which a data frame is to be output based on header information

of the data frame, and a system of determining a port  
from which a data frame is to be output based on the  
10 contents recited in a pay load of the data frame.

51. The base node according to any one of  
claim 46 to claim 49, which determines a port from which  
a data frame is to be output based on a communication  
state of said communication system.

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52. The base node according to any one of  
claim 46 to claim 49, which changes said forwarding data  
base based on a communication state of said  
communication system.

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53. The base node according to any one of  
claim 46 to claim 49, wherein said assuming unit  
includes an address management data base which manages a  
corresponding relationship between all the hosts  
5 connected directly or through at least one node to a  
port not connected to said communication medium among  
ports belonging to said base node of a communication  
partner and said base node of the communication partner,  
and which

10 changes a virtual port registered in output  
port information of said forwarding data base based on a  
communication state of said communication system.

54. The base node according to any one of claim 46 to claim 49, which changes said port mapping table based on a communication state of said communication system.

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55. The base node according to any one of claim 46 to claim 49, which determines a port from which a data frame is to be output based on a failure occurrence position, or on the number of failures occurring, or on both.

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56. The base node according to any one of claim 46 to claim 49, further comprising a filtering mechanism for preventing a plurality of times of reception of the same data frame from said plurality of communication media.

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57. The base node according to any one of claim 46 to claim 49, which when detecting recovery from a failure, preferentially transfers a data frame having high priority or transfers a data frame having low priority with a communication band limited.

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58. The base node according to any one of claim 46 to claim 49, which determines a port from which a data frame is to be output based on a communication state of a port belonging to said base node.

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59. The base node according to any one of claim 46 to claim 49, which changes said forwarding data base based on a communication state of a port belonging to said base node.

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60. The base node according to any one of claim 46 to claim 49, which changes said port mapping table based on a communication state of a port belonging to said base node.

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61. The base node according to any one of claim 46 to claim 49, which manages a corresponding relationship between a host connected directly or through at least one node to other base node than the own-node and the base node other than said own-node.

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62. The base node according to any one of claim 46 to claim 49, which manages a corresponding relationship between a router connected to other base node than the own-node and the base node other than said own-node.

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63. The base node according to any one of claim 40 to claim 45, which transmits and receives a learning frame to notify each other of a host connected to said base node.



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64. The base node according to any one of claim 48 to claim 52, which transmits and receives a data frame whose pay load stores a node identifier of a router connected to said base node to notify each other of the router connected to said base node.

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65. The base node according to claim 53, which transmits and receives an Ethernet (R) frame with a VLAN tag added which stores a VLAN identifier assigned to a combination of said base node to which a transmission source host belongs and said base node to which a destination host belongs to automatically create the address management data base.

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66. A communication control program executed on a node as a base communicating with each other through a plurality of communication media each formed of at least one relay node in a communication system, which comprises

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an assuming function of assuming said plurality of communication media to be one node by handling a plurality of ports connected to said plurality of communication media among ports belonging to said node as a base as one virtual port.

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67. The communication control program

according to claim 66, which comprises the function of registering, for one destination, a plurality of pieces of forwarding information for transferring a data frame transmitted from a certain transmission source to a  
5 predetermined destination in a forwarding data base.

68. The communication control program according to claim 66, which comprises the function of correlating at least one port of said base node with one virtual port in a port mapping table, and registering at  
5 least one said virtual port in forwarding information for transferring a data frame transmitted from a certain transmission source to a predetermined destination in a forwarding data base.

69. The communication control program according to claim 66, which comprises the function of, when transmitting a data frame to said communication medium having a different frame format, transmitting  
5 said data frame with header information of the frame format of said communication medium added and when receiving a data frame from said communication medium, receiving said data frame with the header information of the frame format of said communication medium removed.

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70. The communication control program according to any one of claim 66 to claim 69, which

comprises the function of transmitting and receiving a  
keep alive frame to/from each other to obtain a  
5 communication state of the communication system.

71. The communication control program  
according to claim 70, wherein said keep alive frame is  
broadcast by said relay node forming said plurality of  
communication media with a destination address  
5 recognized as unknown by said relay node forming said  
plurality of communication media recited.

72. The communication control program  
according to claim 70 or claim 71, which comprises the  
function of obtaining a communication state of the  
communication system from information recited in said  
5 keep alive frame or an arrival state of said keep alive  
frame.

73. The communication control program  
according to any one of claim 70 to claim 72, wherein a  
communication state of said communication system is any  
of or an arbitrary combination of a failure, variation  
5 of a communication band and a delay.

74. The communication control program  
according to any one of claim 66 to claim 73, which  
comprises the function of determining a port from which

a data frame is to be output based on any of algorithms  
 5 of a system of determining a port from which a data  
 frame is to be output by a round robin or a weighting  
 round robin, a system of determining a port from which a  
 data frame is to be output based on header information  
 of the data frame, and a system of determining a port  
 10 from which a data frame is to be output based on the  
 contents recited in a pay load of the data frame.

75. The communication control program  
 according to any one of claim 70 to claim 73, which  
 comprises the function of determining a port from which  
 a data frame is to be output based on a communication  
 5 state of said communication system.

76. The communication control program  
 according to any one of claim 70 to claim 73, which  
 comprises the function of changing said forwarding data  
 base based on a communication state of said  
 5 communication system.

77. The communication control program  
 according to any one of claim 70 to claim 73, wherein  
 said assuming unit includes the function of managing a  
 corresponding relationship between all the hosts  
 5 connected directly or through at least one node to a  
 port not connected to said communication medium among

ports belonging to said base node of a communication partner and said base node of the communication partner in an address management data base, and changing a virtual port registered in output port information of said forwarding data base based on a communication state of said communication system.

78. The communication control program according to any one of claim 70 to claim 73, which changes said port mapping table based on a communication state of said communication system.

79. The communication control program according to any one of claim 70 to claim 73, which comprises the function of determining a port from which a data frame is to be output based on a failure occurrence position, or on the number of failures occurring, or on both.

80. The communication control program according to any one of claim 70 to claim 73, further comprising a filtering mechanism for preventing a plurality of times of reception of the same data frame from said plurality of communication media.

81. The communication control program according to any one of claim 70 to claim 73, which

comprises the function of, when detecting recovery from  
a failure, preferentially transferring a data frame  
5 having high priority or transferring a data frame having  
low priority with a communication band limited.

82. The communication control program  
according to any one of claim 70 to claim 73, which  
comprises the function of determining a port from which  
a data frame is to be output based on a communication  
5 state of a port belonging to said base node.

83. The communication control program  
according to any one of claim 70 to claim 73, which  
comprises the function of changing said forwarding data  
base or said port mapping table based on a communication  
5 state of a port belonging to said base node.

84. The communication control program  
according to any one of claim 70 to claim 73, which  
comprises the function of managing a corresponding  
relationship between a host connected directly or  
5 through at least one node to other base node than the  
own-node and the base node other than said own-node.

85. The communication control program  
according to any one of claim 70 to claim 73, which  
comprises the function of managing a corresponding

relationship between a router connected to other base  
5 node than the own-node and the base node other than said  
own-node.

86. The communication control program  
according to any one of claim 66 to claim 69, which  
comprises the function of transmitting and receiving a  
learning frame to notify each other of a host connected  
5 to said base node.

87. The communication control program  
according to any one of claim 72 to claim 75, which  
comprises the function of transmitting and receiving a  
data frame whose pay load stores a node identifier of a  
5 router connected to said base node to notify each other  
of the router connected to said base node.

88. The communication control program  
according to claim 77, which comprises the function of  
transmitting and receiving an Ethernet (R) frame with a  
VLAN tag added which stores a VLAN identifier assigned  
5 to a combination of said base node to which a  
transmission source host belongs and said base node to  
which a destination host belongs to automatically create  
the address management data base.

89. A computer including a network interface

card having the function of communicating with each other through a plurality of communication media each formed of at least one relay node in a communication system, wherein

said network interface card includes an assuming unit which handles a plurality of ports connected to said plurality of communication media among ports belonging to said network interface card as one virtual port to assume said plurality of communication media to be one node.

90. The computer according to claim 89, wherein said assuming unit of said network interface card includes a forwarding data base which registers, for one destination, a plurality of pieces of forwarding information for transferring a data frame transmitted from a certain transmission source to a predetermined destination.

91. The computer according to claim 89, wherein said assuming unit of said network interface card includes a port mapping table which correlates at least one port with one virtual port, and a forwarding data base which registers at least one said virtual port in forwarding information for transferring a data frame transmitted from a certain transmission source to a predetermined destination.



92. The computer according to any one of claim 89 to claim 91, wherein when transmitting a data frame to said communication medium having a different frame format, said network interface card transmits said data frame with header information of the frame format of said communication medium added and when receiving a data frame from said communication medium, receives said data frame with the header information of the frame format of said communication medium removed.

93. The computer according to any one of claim 89 to claim 92, wherein said network interface card transmits and receives a keep alive frame to/from each other to obtain a communication state of the communication system.

94. The computer according to claim 93, wherein said keep alive frame is broadcast by said relay node forming said plurality of communication media, with a destination address recognized as unknown by said relay node forming said plurality of communication media recited.

95. The computer according to claim 93 or claim 94, which obtains a communication state of the communication system from information recited in said

5 keep alive frame or an arrival state of said keep alive frame, or from both.

5 96. The computer according to any one of claim 93 to claim 95, wherein a communication state of said communication system is any of or an arbitrary combination of a failure, variation of a communication band and a delay.

5 97. The computer according to any one of claim 89 to claim 96, wherein said network interface card determines a port from which a data frame is to be output based on any of algorithms of a system of determining a port from which a data frame is to be output by a round robin or a weighting round robin, a system of determining a port from which a data frame is to be output based on header information of the data frame, and a system of determining a port from which a data frame is to be output based on the contents recited in a pay load of the data frame.

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5 98. The computer according to any one of claim 93 to claim 96, wherein said network interface card determines a port from which a data frame is to be output based on a communication state of said communication system.

99. The computer according to any one of claim 93 to claim 96, wherein said network interface card changes said forwarding data base based on a communication state of said communication system.

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100. The computer according to any one of claim 93 to claim 96, wherein said assuming unit of said network interface card includes an address management data base which manages a corresponding relationship between all the hosts connected directly or through at least one node to a port not connected to said communication medium among ports belonging to a communication partner and the communication partner, and which

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changes a virtual port registered in output port information of said forwarding data base based on a communication state of said communication system.

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101. The computer according to any one of claim 93 to claim 96, wherein said network interface card changes said port mapping table based on a communication state of said communication system.

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102. The computer according to any one of claim 93 to claim 96, wherein said network interface card determines a port from which a data frame is to be output based on a failure occurrence position, or on the

5 number of failures occurring, or on both.

103. The computer according to any one of claim 93 to claim 96, wherein said network interface card includes a filtering mechanism for preventing a plurality of times of reception of the same data frame from said plurality of communication media.

104. The computer according to any one of claim 93 to claim 96, wherein said network interface card, when detecting recovery from a failure, preferentially transfers a data frame having high priority or transfers a data frame having low priority with a communication band limited.

105. The computer according to any one of claim 93 to claim 96, wherein said network interface card determines a port from which a data frame is to be output based on a communication state of a port belonging to said node.

106. The computer according to any one of claim 93 to claim 96, wherein said network interface card changes said forwarding data base based on a communication state of a port belonging to said node.

107. The computer according to any one of

claim 93 to claim 96, wherein said network interface card changes said port mapping table based on a communication state of a port belonging to said node.

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108. The computer according to any one of claim 93 to claim 96, wherein said network interface card manages a corresponding relationship between a host connected directly or through at least one node to other node than the own-node and the node other than said own-node.

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109. The computer according to any one of claim 93 to claim 96, wherein said network interface card manages a corresponding relationship between a router connected to other node than the own-node and the node other than said own-node.

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110. The computer according to any one of claim 89 to claim 92, wherein said network interface card transmits and receives a learning frame to notify each other of a host connected to said node.

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111. The computer according to any one of claim 95 to claim 99, wherein said network interface card transmits and receives a data frame whose pay load stores a node identifier of a router connected to said node to notify each other of the router connected to

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said node.

112. The computer according to claim 100,  
 wherein said network interface card transmits and  
 receives an Ethernet (R) frame with a VLAN tag added  
 which stores a VLAN identifier assigned to a combination  
 5 of said node to which a transmission source host belongs  
 and said node to which a destination host belongs to  
 automatically create the address management data base.

113. The computer according to any one of  
 claim 89 to claim 112, including said network interface  
 card in the plural, each network interface card being  
 connected to individual said communication medium or an  
 5 arbitrary number of said communication media.